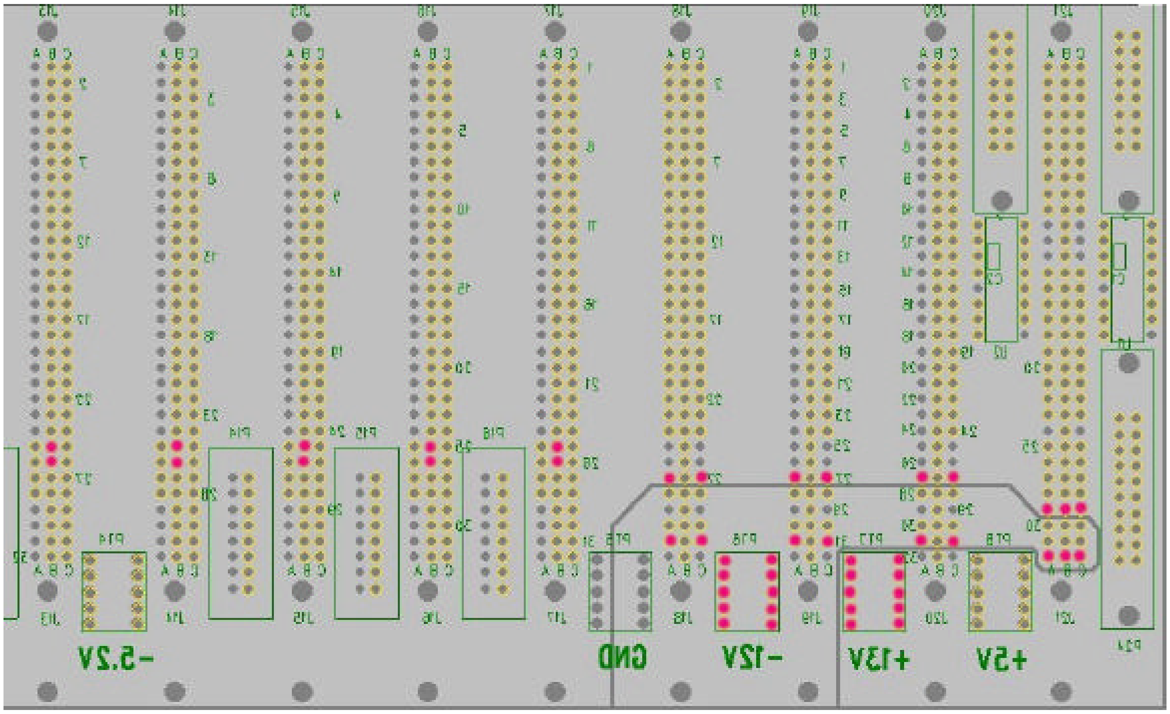
BLS Back Plane Power Distribution
Revision A October 11, 2000

The center, P2, back plane distributes the following power rails.

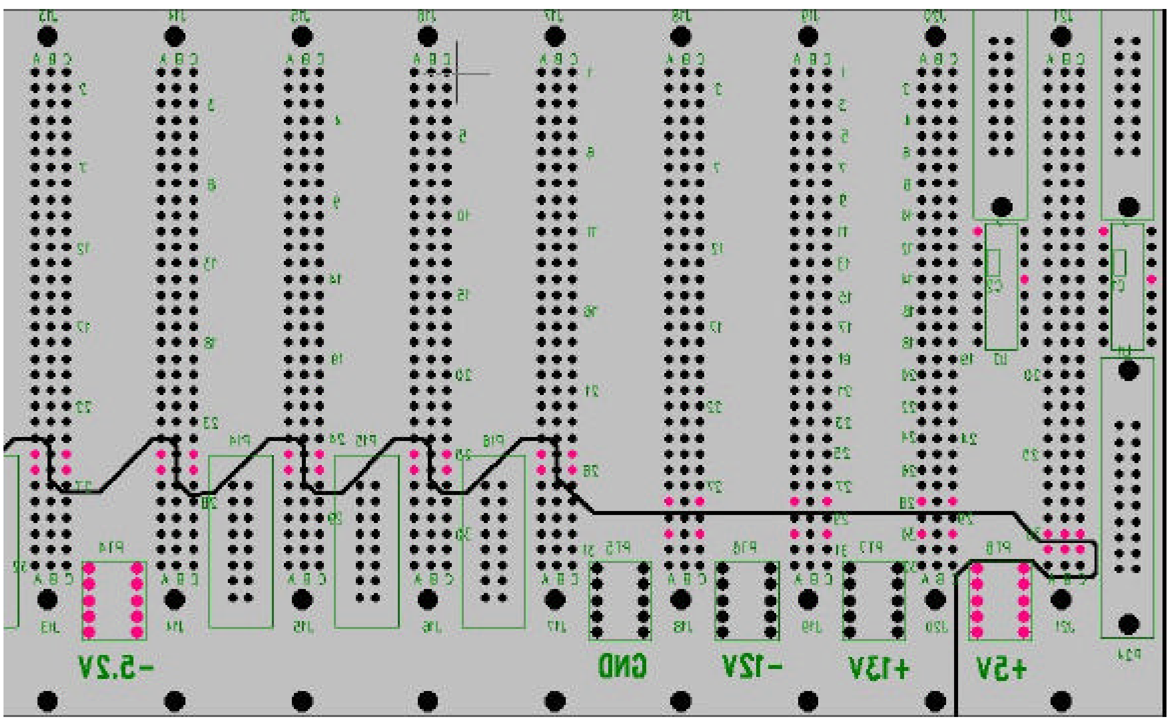
- +13V @ 20A
- -12V @ 5A
- +5V @ 20A
- -5.2V @ 10A

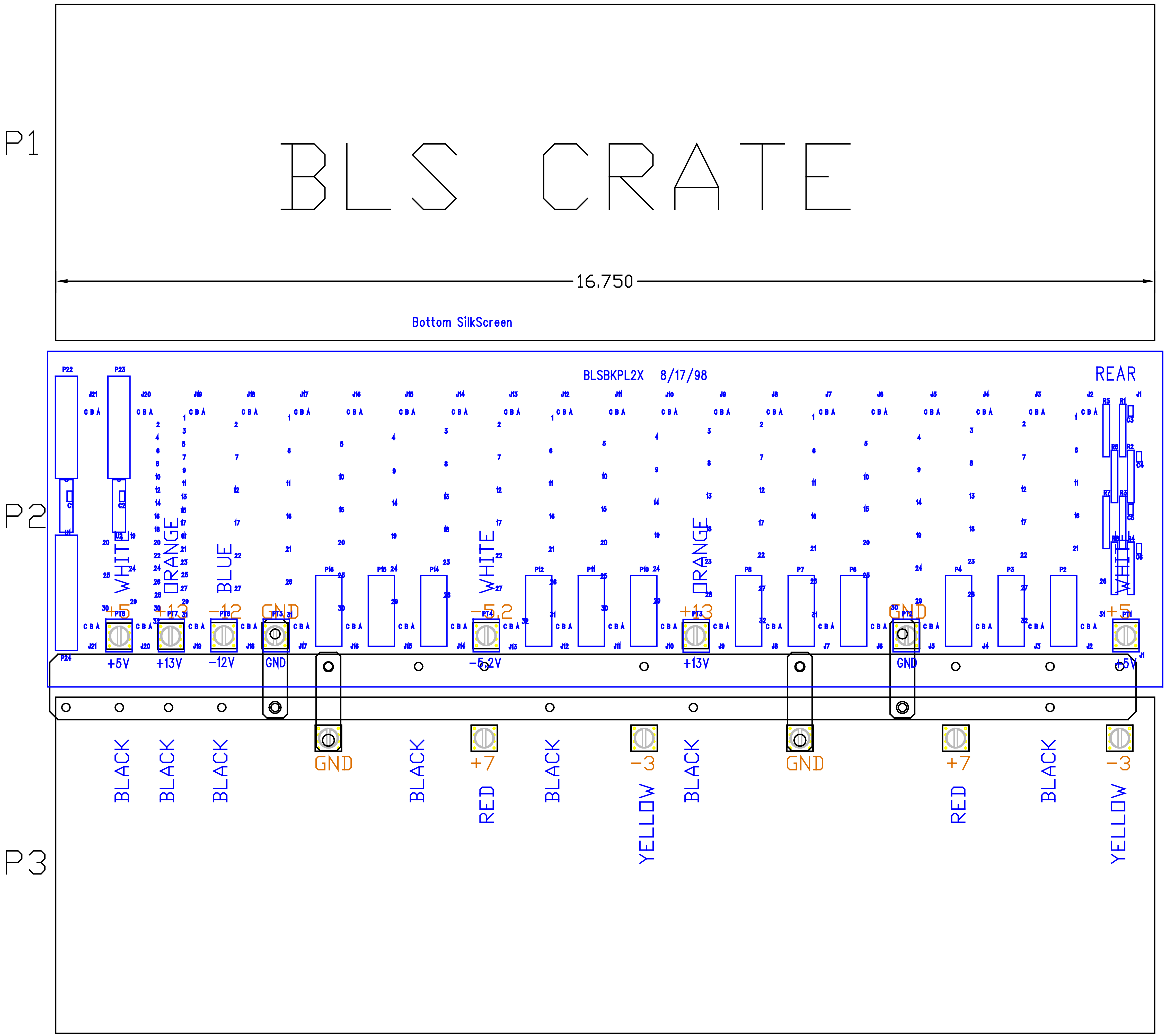
Power connections are made with AMP Part number power bug 55556-4. These power tap devices are tested at 25Amps. The current rating can be seen on the chart in the data sheet included in this document. All power bugs are ten (10) position units. The bugs and the card connectors are press fit components and the PCB connections are directly made without thermal-relief. Power planes within the back plane carry the four rails listed above on two layers. The planes are split such that +5V & -5.2V are on one plane and +13V & -12V are on the other plane. Ground occupies a third plane by itself.
The BLS Mother Board has two pins for the +13V, +5V and –5.2V from the P2 connector, and four pins for the +7V and –3V rails from the P3 connector. This is shown on page 1 of the BLS Mother Board schematics. NOTE the B-row of P1 & P3 is not present on the existing crate even though it is implemented on the new BLS Mother Board.
The BLS Crate Controller Boards have three pins for each power rail as shown on page 3 of the schematics. The nodes are labeled with an ‘S’ prefix to denote ‘source’.

Looking at these planes in detail shows in general the power to the cards in provided on two pins of the DIN connector. The pins are highlighted in red that connect to the plane.



The last connector on the right is for the Crate Controller and has three pins for power.




P1
BLS CRATE
16.750
Bottom SilkScreen
P2
BLSBKPL2X 8/17/98
REAR
WHITE
ORANGE
BLUE
WHITE
ORANGE
WHITE
+5
+13
-12
GND
-5.2
+13
GND
+5
+5V
+13V
-12V
GND
-5.2V
+13V
GND
+5V
P3
BLACK
BLACK
BLACK
GND
BLACK
+7
RED
BLACK
-3
YELLOW
BLACK
GND
+7
RED
BLACK
-3
YELLOW

November 26,1990

To: A Visser RD/EED
From Merle Haldeman RD/EED/DES
Subject D0 Electrical Review

As a member of the D0 Electrical Review Committee, I was asked to look at the current handling ability of the connection between the **Amp Power Distribution Taps** and the associated backplanes for the **Base Line Subtracter** BLS and **Shaper** crates. The two areas where concern was focused were

1. The interface between the plated through holes, into which the power taps are pressed, and the backplane buss, and
2. the backplane buss current handling ability.

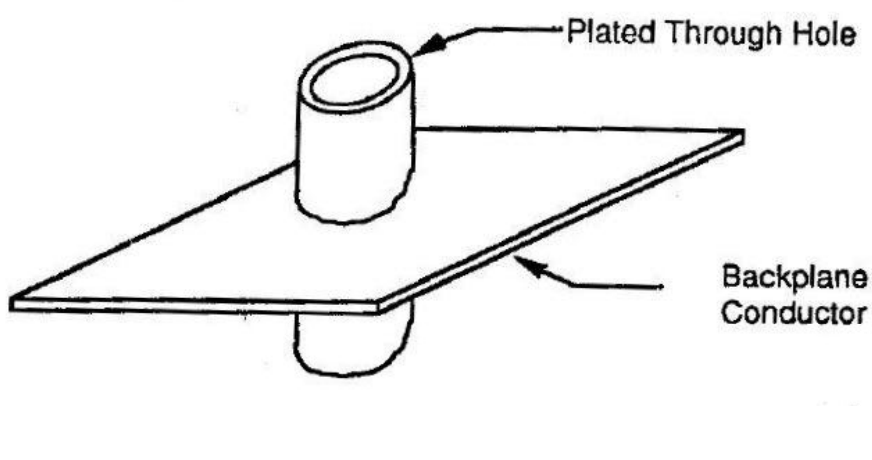
For the area of interface between the plated through holes and the backplane conductor, I start by calculating the approximate fusing current and attempt to keep the operating current at least an order of magnitude below that value.

According to page 4-55 (5th edition) of the "Reference Data for Radio Engineers", published by Howard W. Sams and Co., "The current I in amperes at which a wire will melt can be calculated from;

$$I = kd^{(3/2)}$$

where d = wire diameter in inches
k = a constant that depends on the metal used in the conductor.

From table 39, on page 4-54, k for copper is equal to 10244.



Rather than express the fusing current in terms of wire diameter, we express it in terms of conductor area, A, perpendicular to the current flow.

Since A for a wire is $\pi \cdot r^2 = \pi \cdot \left(\frac{d}{2}\right)^2$; $d = \left(\frac{4A}{\pi}\right)^{\frac{1}{2}}$,

we get $I = k \cdot \left(\frac{4A}{\pi}\right)^{\frac{3}{4}}$

which reduces to $I = 12279 \cdot A^{3/4}$

Instructional Sheet, IS3001, provided by AMP Inc., recommends a maximum current of 2.5 amperes per pin with a minimum hole diameter of 0.037". A plated through hole of this inside diameter, will make contact with a 2oz. (0.0028") backplane conductor over an area of 0.000343 in^2. From this area, the fusing current would calculated to be

$$I = 12279 \cdot (0.000343)^{3/4} = 31 \text{ amperes.}$$

Since this is considerably more than ten times the current likely to be present plus the additional cooling present due to the construction of the backplane, I feel this method of bringing the DC power onto the backplane is excellent in terms of fire and safety.

Regarding the current capacity of the backplane itself, I use the graphs illustrated on page 4 of IPC-D-949, Jan., '87 (copy attached) which gives temperature rise for various combinations of conductor shape and amperage for both external and internal conductors.

George Krafczyk described the BLS backplane busses to me as being constructed of two ounce copper approximately 1" wide with an effective width of about 0.8" due to openings etched in the conductor. According to D. Huffman, the maximum current supplied to the BLS crates is 20 amperes for both, the 13 volts and the -5 Volts Assuming the worse case of internal conductors, the temperature rise might approach 10°C. FR-4 material has a maximum operating temperature of 125°C.

.8 x .0028 = .00224 in^2 [illegible] mils

20 Amps [illegible] amps

J = 8929 A/in^2

Ken Bourkland and I looked at the artmasters for the Shaper backplane, plus and minus 12 volt busses which, according to D. Huffman, may carry up to 30 amperes. This 30 amperes is brought to each buss via three of the, ten pin, Amp Power Distribution Taps. This distribution of current allows 1 ampere per pin which, as indicated above, is plenty safe. The width of the buss is about 0.75". This current may produce a temperature rise of about 20°C which is still safe. The 15 volt, , 5 amp busses will run with less than a 10°C rise: again safe.

In summary, I believe the construction of the backplanes for both the BLS and Shaper crates are adequately designed for the stated voltages and currents. The actual temperature rises should be considerably lower than stated since all the current does not run the length of the buss but is instead injected at several points on the bus. Also the large amount of copper in the backplane for circuits other than power, will obviously conduct heat to be dissipated over a larger area lowering the temperature of the buss.

Copies:

K. Bourkland	AD/EE	MS308
R. Hance	RD/EED	MS 222
D. Huffman	RD/D0	MS352
M. Johnson	RD/D0	MS357
G. Krafczyk	AD/EE	MS308
S. Orr	RD/EED	MS222
J. Ryk	AD/EE	MS308

DØ

LOW VOLTAGE, HIGH CURRENT ELECTRICAL SUBSYSTEM SAFETY REVIEWS

NOTE: ALL APPROVALS BY HEAD OF ELECTRICAL SAFETY COMMITTEE!

REGION	REVIEWED AND APPROVED BY	DUE DATE/DATE
Center Platform: Tracking Shaper and CC BLS Racks	Age Visser Print Name	Due Date
	[signature] Signature	2/18/92 Date
Comments/Exceptions:	NONE	
North Center Platforom: ECN BLS Racks and Level 0 Trigger	Age Visser Print Name	Due Date
	[signature] Signature	4/1/92 Date
Comments/Exceptions:	2/17/92 WAITING FOR INFO 4/1/92 Complete	
South Center Platform: ECS BLS Racks and Level 0 Trigger	Age Visser Print Name	Due Date
	[signature] Signature	4/1/92 Date
Comments/Exceptions:	2/17/92 WAITING FOR INFO 4/1/92 Complete	

(For use in determining current carrying capacity and sizes of etched copper conductors for various temperature rises above ambient

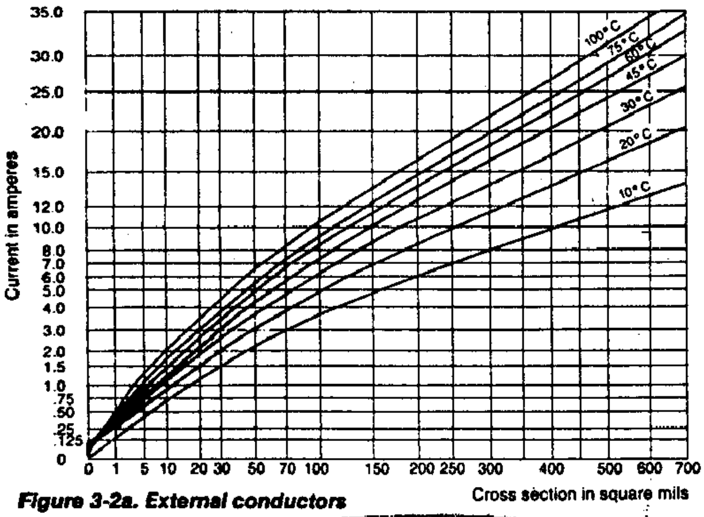


Figure 3-2a. External conductors

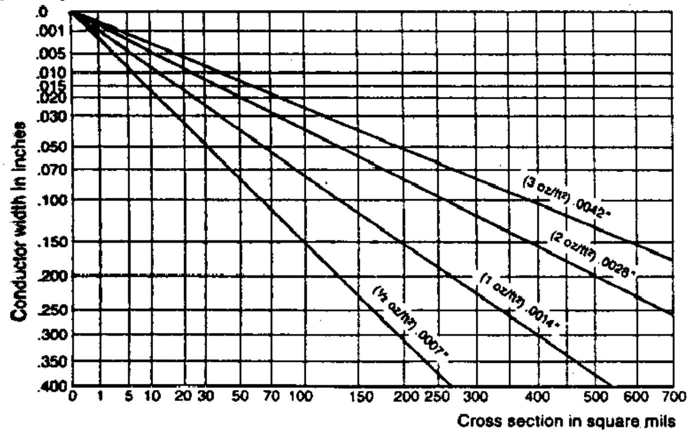


Figure 3-2b. Conductor width to cross-section relationship.

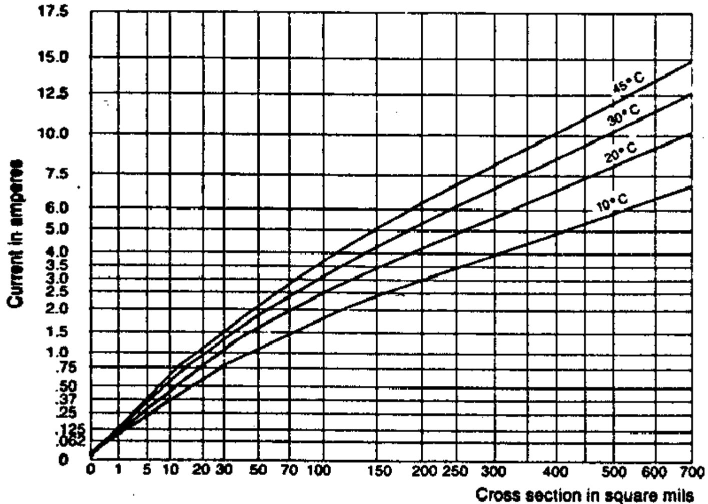


Figure 3-2c. Internal conductors.

NOTES:

1. The design chart has been prepared as an aid in estimating temperature rises (above ambient) vs current for various cross-sectional areas of etched copper conductors. It is assumed that, for normal design, conditions prevail where the conductor surface area is relatively small compared to the adjacent free panel area. the curves as presented include a nominal 10 percent derating (on a current basis) to allow for normal variations in etching techniques, copper thickness, conductor width estimates, and cross-sectional area.

2. Additional derating of 15 percent (current-wise) is suggested under the following conditions:
   (a) For panel thickness of 1/32 inch or less.
   (b) For conductor thickness of 0.0042 inch (3 oz/ft²) or thicker.

3. For general use the permissible temperature rise is defined as the difference between he maximum safe operating temperature of the laminate and the maximum ambient temperature in the location where the panel will be used.

4. For single conductor applications the chart may be used directly for determining conductor widths, conductor thickness, cross-sectional area, and current-carrying capacity for various temperature rises.

5. For groups of similar parallel conductors, if closely spaced, the temperature rise may be found by using an equivalent cross-section and an equivalent current. The equivalent cross-section is equal to the sum of the cross-section of the parallel conductors, and the equivalent current is the sum of the currents in the conductors.

6. The effect of heating due to attachment of power dissipating parts is not included.

7. The conductor thicknesses in the design chart do not include conductor overplating with metals other than copper.

IPC-I-00005

Figure 3-2. Conductor thickness and width for internal and external layers

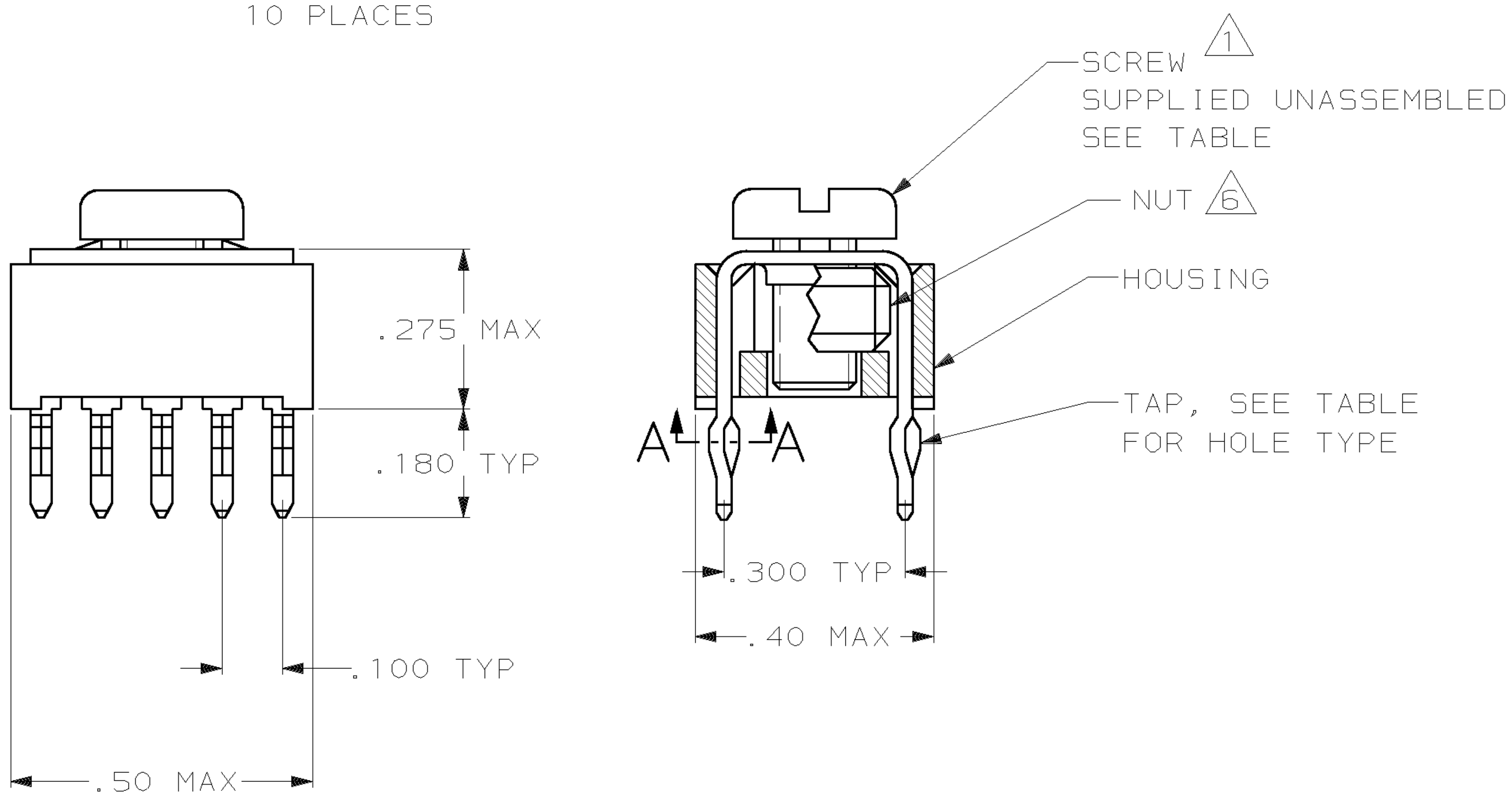
THIS DRAWING IS UNPUBLISHED. RELEASED FOR PUBLICATION .19 .

LOC	DIST
AR	0

REVISIONS

P	LTR	DESCRIPTION	DATE	DWN	APVD
	N	PER EC .504-0112-97	6-17-97	TS	HJ
	P	ADDED 1-2 AND 1-3 PER EC 0G1C-0208-98	15 DEC 98	CD	WO

SECTION A-A
SCALE 10:1
10 PLACES



△1 TO PREVENT THREAD STRIPPING, SCREW TORQUE SHOULD NOT EXCEED 9 IN LBS.

△2 TAP HOLE IS 6-32UNC-2B, TWO MIN THREADS.

△3 TAP HOLE IS M4 X 0.7, TWO MIN THREADS.

△4 PACKAGED BULK.

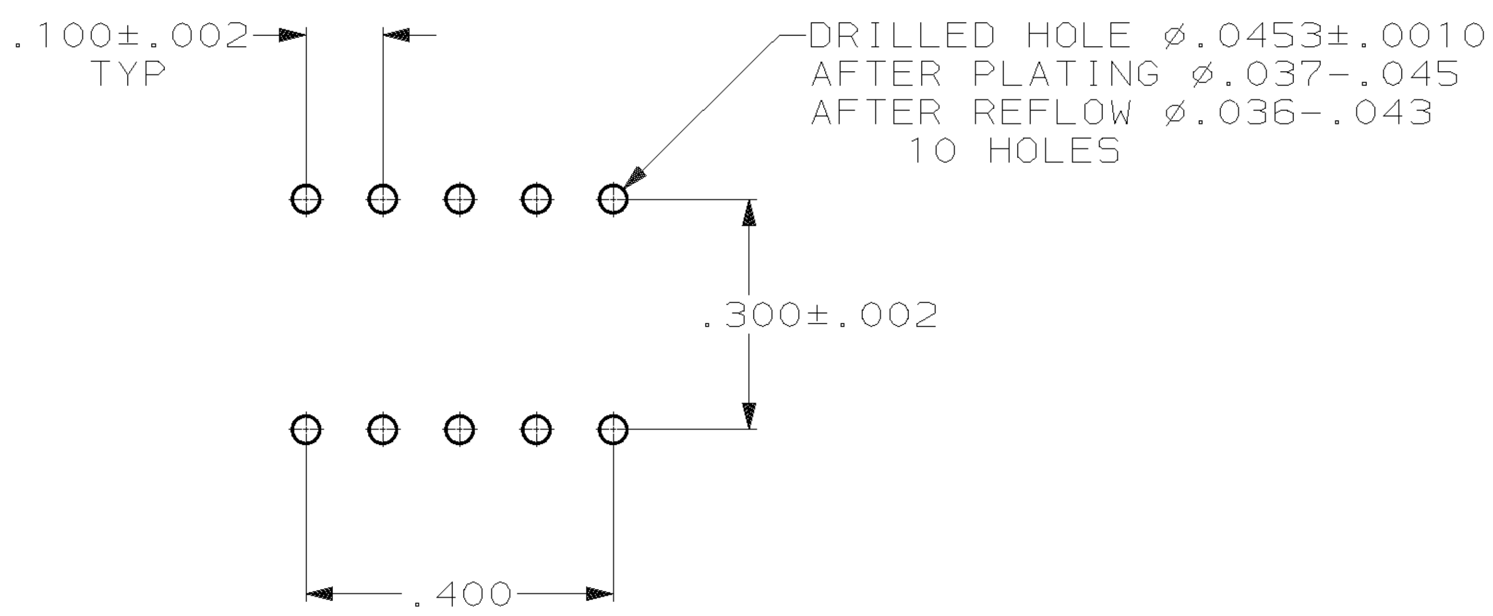
△5 PACKAGED INDIVIDUALLY.

△6 NUT INCREASES TORQUE VALUE TO 26 IN LBS.

△7 HOUSING: NYLON UL 94V-0.
TAP: COPPER ALLOY 735, .025 THICK.

△8 TAP: .000150 TIN-LEAD OVER .000050 NICKEL.

△9 CLEARANCE HOLE FOR A 6-32 SCREW.



PC BOARD PATTERN

	PACKAGING	HOLE TYPE	HOUSING COLOR	HOUSING AND TAP ASSEMBLED	SCREW	PART NO
	△4	△9	BLACK	△6 YES (W/NUT)	NO	1-55556-3
	△4	△9	BLACK	△6 YES (W/NUT)	6-32UNC-2A X .250	1-55556-2
OBSOLETE	△5	△2	BLACK	YES	6-32UNC-2A X .250	1-55556-1
SUPSD BY -9	-	△3	BLACK	YES	NO	1-55556-0
	△4	△3	BLACK	YES	M4 X 0.7 X 6MM	55556-9
SUPSD BY -4	-	△2	WHITE	YES	6-32UNC-2A X .250	55556-8
SUPSD BY -4	-	△2	GREEN	YES	6-32UNC-2A X .250	55556-7
SUPSD BY -4	-	△2	BLUE	YES	6-32UNC-2A X .250	55556-6
SUPSD BY -4	-	△2	RED	YES	6-32UNC-2A X .250	55556-5
	△4	△2	BLACK	YES	6-32UNC-2A X .250	55556-4
	△4	△2	BLACK	YES	NO	55556-3
OBSOLETE	-	△2	BLACK	NO	6-32UNC-2A X .250	55556-2
	-	△2	BLACK	NO	NO	55556-1

THIS DRAWING IS A CONTROLLED DOCUMENT.

DIMENSIONS: INCHES

TOLERANCES UNLESS OTHERWISE SPECIFIED:
0 PLC ±-
1 PLC ±-
2 PLC ±-
3 PLC ±.010
4 PLC ±-
ANGLES ±-

MATERIAL △7
FINISH △8

DWN J.McCLINTON 1-11-88
CHK R.STONE 1-11-88
APVD M.GALLOWAY 1-11-88
PRODUCT SPEC 108-11030
APPLICATION SPEC 114-1100
WEIGHT -
CUSTOMER DRAWING

AMP

AMP Incorporated
Harrisburg, PA 17105-3608

NAME
TAP ASSEMBLY,
POWER DISTRIBUTION

SIZE	CAGE CODE	DRAWING NO	RESTRICTED TO
A2	00779	C- 55556	-

SCALE 4:1 | SHEET 1 OF 1 | REV P

55556

AMP 1471-9 REV 11JUN97

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PRODUCT SPECIFICATION

1. SCOPE

1.1. Content

This specification covers performance, tests and quality requirements for AMP* power distribution tap. These taps are available in .100 X .300 and .125 X .250 inch centerlines. The .125 X .250 taps are available in 6 and 10 position while the .100 X .300 tap is available in 10 position only.

1.2. Definitions

For the purpose of this specification, the following definitions shall apply.

- A. Power Distribution Tap: A printed circuit board mounted device intended as an interface between printed circuit board and power leads.
- B. ACTION PIN* Contacts: Pins used on power distribution tap for distributing current to printed circuit board.

1.3. Qualification

When tests are performed on subject product line, procedures specified in AMP 109 series specifications shall be used. All inspections shall be performed using applicable inspection plan and product drawing.

2. APPLICABLE DOCUMENTS

The following documents constitute a part of this specification to the extent specified herein. In the event of conflict between requirements of this specification and product drawing, product drawing shall take precedence. In the event of conflict between requirements of this specification and referenced documents, this specification shall take precedence.

2.1. AMP Documents

- A. 109-1: General Requirements For Test Specifications
- B. 109 Series: Test Specifications as indicated in Figure 1. (Comply with MIL-STD-202, MIL-STD-1344 and EIA RS-364)
- C. Corporate Bulletin 401-76: Cross reference between AMP Test Specifications and Military or Commercial Documents
- D. 114-11000: Application Specification
- E. 501-215: Test Report

* Trademark

Product Code: 3463

3. REQUIREMENTS

3.1. Design and Construction

Product shall be of design, construction and physical dimensions specified on applicable product drawing.

3.2. Materials

A. Contact: Copper alloy 725
B. Housing: Thermoplastic, UL94V0

3.3. Ratings

A. Current: See Figure 2 for applicable current carrying capability
B. Temperature: -55 to 85°C

3.4. Performance and Test Description

Product is designed to meet electrical, mechanical and environmental performance requirements specified in Figure 1. All tests performed at ambient environmental conditions per AMP Specification 109-1 unless otherwise specified.

3.5. Test Requirements and Procedures Summary

Test Description	Requirement	Procedure
Examination of product.	Meets requirements of product drawing and AMP Spec 114-11000.	Visual, dimensional and functional per applicable quality inspection plan.
	ELECTRICAL	
Termination resistance, specified current.	Posn / Test Current amperes / Resistance maximum milliohms 6 / 15 / .5 10 / 25 / .4	Measure potential drop of mated contacts assembled in housing. Calculate resistance. See Figure 7. AMP Spec 109-25.
Termination resistance, dry circuit.	Posn / Resistance maximum milliohms 6 / .5 10 / .4	Subject connectors to 1 ampere test current and millivolt test method. AMP Spec 109-3.
Current cycling.	See Note (a).	Subject mated contacts to 250 cycles at 31.25 amps for 15 minutes ON and 15 minutes OFF. AMP Spec 109-51.
Temperature rise vs current.	30°C maximum temperature rise at specified current.	Measure temperature rise vs current. See Figures 2 and 5. AMP Spec 109-45-1.

Figure 1 (cont)

Test Description	Requirement	Procedure
MECHANICAL		
Random vibration.	No discontinuities greater than 10 microseconds. See Note (a).	Subject mated connectors to 16.91 G's rms for 20 minutes in each of 3 mutually perpendicular planes. See Figure 6. AMP Spec 109-21-5.
Board insertion force.	400 pounds maximum for 10 position. 240 pounds maximum for 6 position.	Measure force necessary to mount tap onto test board using proper mounting fixture per applicable Instruction Sheet. See Figure 4.
Board extraction force.	70 pounds minimum for 10 position. 42 pounds minimum for 6 position.	Measure force necessary to remove tap from test board.
Torque.	See Note (a).	Apply 9 inch pounds torque to tap screw terminal, hold 15 seconds and release.
ENVIRONMENTAL		
Thermal shock.	See Note (a).	Subject taps with wire in place to 500 cycles between -55 and 85°C. AMP Spec 109-22.
Humidity-temperature cycling.	See Note (a).	Subject taps with wire in place to 10 humidity-temperature cycles between 25 and 65°C at 95% RH. AMP Spec 109-23-4, Condition B.
Temperature life.	See Note (a).	Subject taps with wire in place to temperature life at 85°C for 168 hours duration. AMP Spec 109-43.

(a) Shall meet visual requirements, show no physical damage and shall meet requirements of additional tests specified in Test Sequence in Figure 3.

Figure 1 (end)

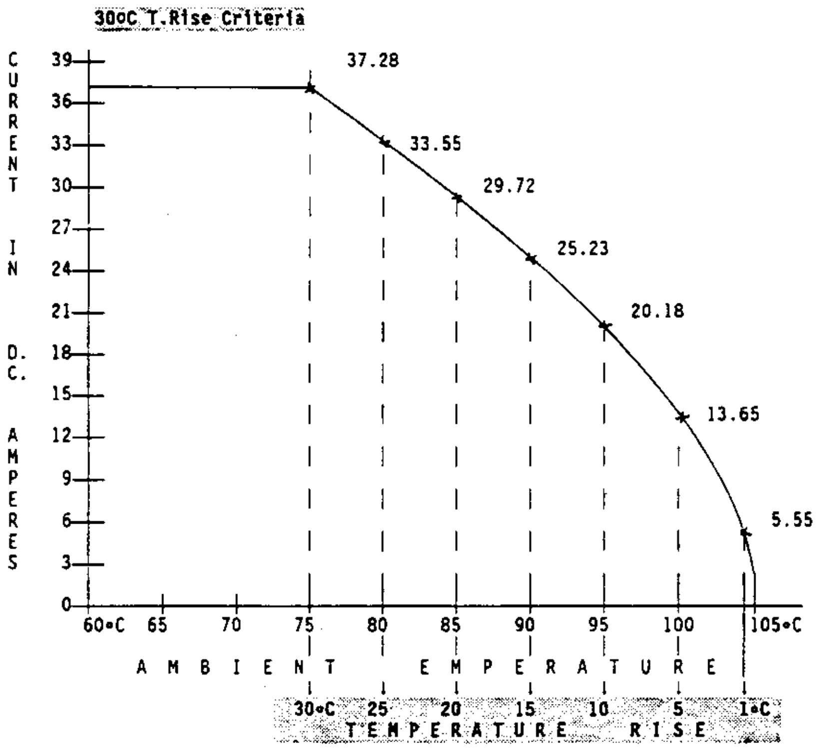


Figure 2A
Current Carrying Capability

Wire Size AWG →	10	12
Connector Size ↓		
6 position	.91	.75
10 position	1.00	.82

Note: To determine acceptable current carrying capacity for connector size and wire gage indicated, use Multiplication Factor (F) from above chart and multiply times Base Rated Current for single circuit at maximum operating temperature shown in Figure 2A.

Figure 2B
Current Rating

3.6. Product Qualification And Requalification Test Sequence

Test or Examination	Test Group (a)			
	1	2	3	4
	Test Sequence (b)			
Examination of product	1	1	1	1
Termination resistance, specified current (c)	4,7,9,11	3,5,7,9		
Termination resistance, dry circuit				3,8
Current cycling		6		
Temperature rise vs current	5	10	2	4,9
Vibration	8			7
Board insertion force	2			
Board extraction force	12			
Torque	3,10	2,8		2
Thermal shock		4		
Humidity-temperature cycling	6			5
Temperature life				6

(a) See Para 4.1.A.
(b) Numbers indicate sequence in which tests are performed.
(c) 25 amps for 10 pin, 15 amps for 6 pin

Figure 3

4. QUALITY ASSURANCE PROVISIONS

4.1. Qualification Testing

A. Sample selection.

Taps shall be prepared in accordance with applicable Instruction Sheets and shall be selected at random from current production. Test groups 1 and 2 shall consist of 30 samples of 10 position, high profile, insulated power tap mounted to double sided printed circuit board. Test group 3 shall consist of 3 each of both 6 (.100 X .300) and 10 position (.125 X .250) taps (uninsulated, insulated low profile and insulated high profile) with and without anti-rotation embossments mounted to both single and double sided printed circuit boards. Test group 4 shall consist of 30 each of 10 position high profile and 6 position uninsulated taps mounted to double sided printed circuit boards. Test groups 1, 2 and 3 shall be wired with 12AWG wire, test group 4 with 10AWG wire. Wires shall be attached to taps using appropriate size PIDG terminals. Wire lengths shall meet minimum requirements of AMP Specification 109-45. Printed circuit test boards shall be both single and double clad with .5 X .100 traces of 2 ounce copper.

B. Test sequence.

Qualification inspection shall be verified by testing samples as specified in Figure 3.

4.2. Requalification Testing

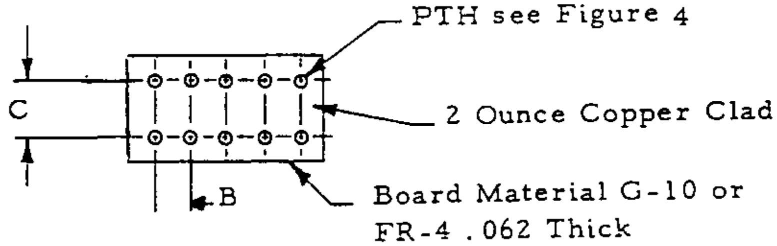
If changes significantly affecting form, fit or function are made to product or manufacturing process, product assurance shall coordinate requalification testing consisting of all or part of original testing sequence as determined by development/product, quality and reliability engineering.

4.3. Acceptance

Acceptance is based upon verification that product meets requirements of Figure 1. Failures attributed to equipment, test setup or operator deficiencies shall not disqualify product. When product failure occurs, corrective action shall be taken and samples resubmitted for qualification. Testing to confirm corrective action is required prior to resubmittal.

4.4. Quality Conformance Inspection

Applicable AMP quality inspection plan will specify acceptable quality sampling level to be used. Dimensional and functional requirements shall be in accordance with applicable product drawing and this specification.



Tap Size	B Dim	C Dim
.125 X .250	.125	.250
.100 X .300	.100	.300

Hole Type	Drill Size	Drilled Hole ø ± .001	Plating Thickness		Hole Diameter		Copper Hardness (Knoop)
			Copper	Tin-lead	After Plating	After Reflow	
A	1.15mm	.0453	.001 to .003	.0003 min	.037 to .043	.036 to .043	150 max

Figure 4
Printed Circuit Test Board

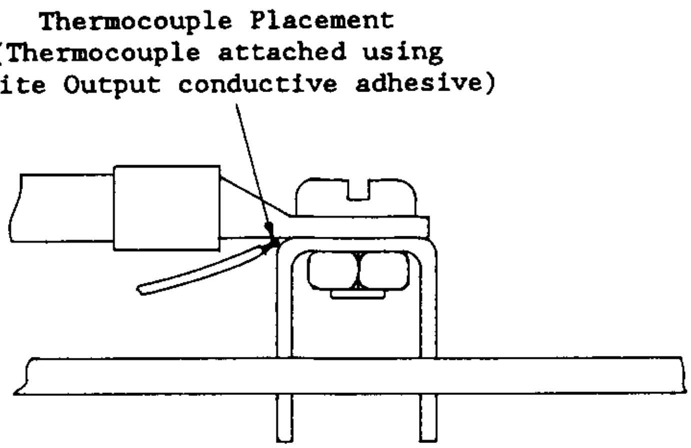


Figure 5
Thermocouple Mounting

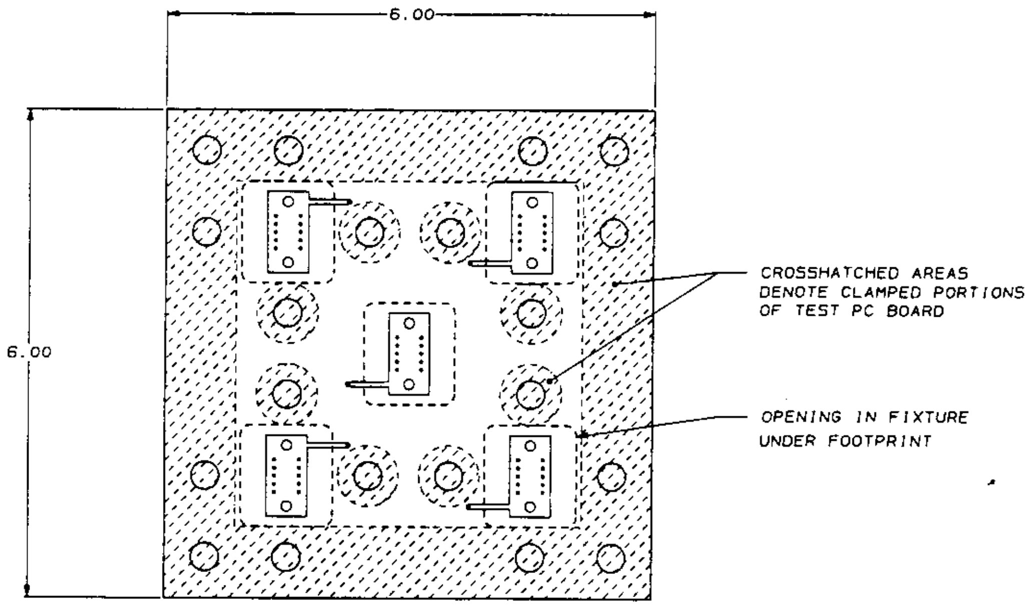


Figure 6
Vibration

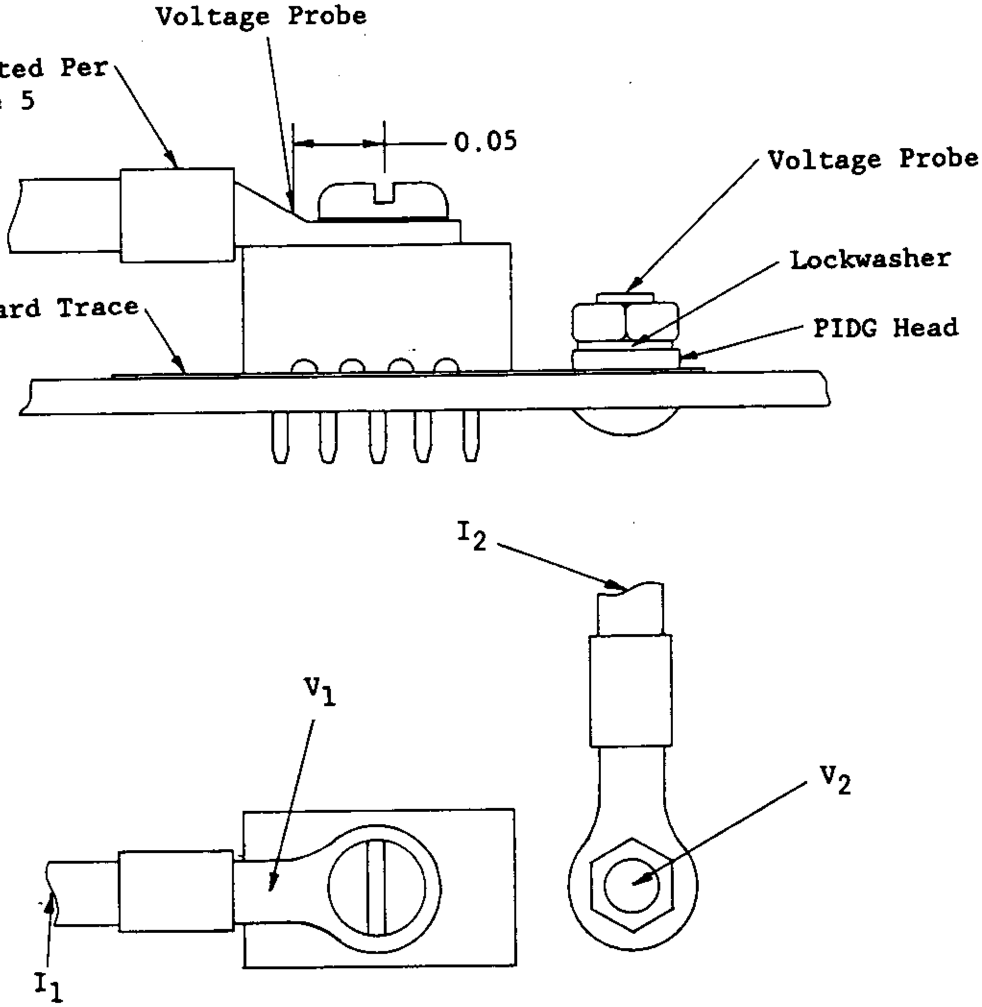


Figure 7
Termination Resistance Probe Locations